

Amendments to the Specification:

Please amend the specification as follows:

A substitute specification with marked up version is being submitted for the examiner's consideration.

SUBSTITUTE SPECIFICATION

A/C Bus Assembly For Electronic Traction Vehicle

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a Divisional application of U.S. Application Serial Number 09/774,981, filed January 31, 2001, now U.S. Patent No. 6,757,597.

FIELD OF THE INVENTION

[0002] The present invention relates generally to hybrid electric traction vehicles and, more particularly to an A/C bus assembly for an electronic traction vehicle

BACKGROUND OF THE INVENTION

[0003] In a conventional electric traction vehicle, a prime mover, such as a diesel engine, is used to drive an electric generator or alternator which supplies electric current to a plurality of traction motors. The traction motors typically are coupled to wheel sets on the vehicle. The vehicles that utilize this type of hybrid electric traction are typically railroad locomotives.

[0004] The prime mover drives the generator/alternator that typically produces an A/C current that is then fully rectified with resulting D/C current and voltage being distributed to current inverters coupled to the traction motors. Such systems are highly integrated with each of the components typically designed and manufactured to operate with the other components in the overall system. In other words, "off the shelf" components are not readily adaptable for use in the initial design or ongoing maintenance of such vehicles. Further, such vehicles have multiple components associated with the change of A/C to D/C to A/C power. Maintenance of such systems is expensive since specific components must be used.

[0005] Thus, there is a need for an electronic traction vehicle that is modular in design. There is a further need for an electronic traction vehicle that utilizes A/C power generated on the vehicle without converting the A/C power to D/C

power. There is also a need for electronic traction vehicle that can be updated and upgraded as new technology and components become available without a required redesign of the overall vehicle system.

SUMMARY OF THE INVENTION

[0006] The present invention provides an electronic traction vehicle comprising a principal power unit, a power storage unit mounted on a vehicle platform. A plurality of wheels are rotably mounted on the vehicle platform with an electric motor coupled to at least one wheel. A drive controller is coupled to the electric motor and a vehicle controller having an input and output terminal is coupled to the drive controller. A data bus network is coupled to the drive controller and the vehicle controller. An A/C bus assembly is coupled to the principal power unit, the power storage unit and the electric motor through the drive controller. Another embodiment of the electronic traction vehicle provides at least four electric motors and four drive controllers coupled to four wheels and the data bus network and A/C power bus assembly. Another embodiment of the electronic traction vehicle provides the components of the vehicle as moduled including an auxiliary module removably connected to the data bus network and the A/C bus assembly.

[0007] The present invention also provides an A/C bus assembly for interconnecting removable modules of an electronic traction vehicle. The modules include a principal power unit, a power storage unit an electric motor coupled to at least one wheel of the vehicle, a drive controller coupled to the electric motor, an electric dissipation unit, and a vehicle controller having a user interface all mounted on the vehicle. The A/C bus assembly comprises a first conductor having a first end and a second end and a second conductor having a first end and a second end wherein the first end of each conductor is coupled to the principal power unit and the second end of each conductor is connected to one of the modules. Another embodiment of the A/C bus assembly includes a third conductor having a first end and a second end with the first end coupled to the principal power unit and the second end coupled to one of the modules. A further embodiment of the A/C bus assembly includes a fourth

conductor having a first end and a second end with the first end coupled to the principal power unit and the second end coupled to a ground terminal mounted on the vehicle, wherein the fourth conductor provides a neutral for interconnecting the modules. A junction is provided where modules can be connected to each of the conductors.

[0008] The present invention also provides a vehicle comprising a vehicle support structure having a plurality of wheels rotably supported by the vehicle structure wherein at least two of the wheels are steerable. A principal power unit is supported by the structure. At least one electric motor is coupled to at least one of the wheels of the vehicle. An electric A/C power bus including at least two phase conductors, wherein the phase conductors are coupled to the principal power unit and a power storage unit. A vehicle controller is coupled to the electric motor and the A/C power bus, a data bus coupled to the vehicle controller and a motor drive controller which communicates signals to the vehicle controller such that the speed and/or torque of the motor are controlled based upon the signals. The motor drive control unit is coupled to the electric motor. Another embodiment of the vehicle includes an energy dissipation unit coupled to the A/C power bus and the data bus and further embodiments of the vehicle includes a plurality of suspension assemblies, wherein each assembly independently suspends one of the wheels relative to the vehicle support structure.

[0009] ~~The present invention also relates to a method of transferring data indicative of an electronic traction vehicle to potential customers over the Internet. The method includes obtaining information on the electronic traction vehicle, the electronic traction vehicle including a vehicle platform, a principal power unit mounted on the vehicle platform, a power storage unit mounted on the vehicle platform, a plurality of wheels rotably mounted on the vehicle platform, an electric motor coupled to at least one wheel, a drive controller coupled to the electric motor, a vehicle controller having an input and output terminal, the vehicle controller connected to the drive controller and a data bus network, and, an AC bus assembly to~~

~~couple the principal power unit, the power storage unit and the electric motor through the drive controller. The method further includes entering the information on a terminal, the terminal operationally connected to an Internet server, the Internet server operationally connected to the Internet, and transmitting to the information from the terminal to the Internet through an Internet server.~~

[0009] There is further provided a method of transferring selected vehicle data. The method includes generating selected data representative of an electric vehicle. The electric vehicle is of the type including a principal power unit that is not a battery, a power storage unit, a plurality of wheels, an electric motor coupled to at least one wheel, a drive controller coupled to the electric motor, a vehicle controller having an input and an output terminal, and coupled to the drive controller and a data bus network, and an AC bus assembly coupled to the principal power unit, the power storage unit, and the electric motor through the drive controller. The method further includes entering the selected data on a terminal, the terminal operationally connected to an Internet server, the internet server operationally connected to the Internet and transmitting the data from the terminal to the Internet through the internet server.

[0010] It is further provided a method including communicating over a network data representative of a vehicle of the type including a vehicle structure, a principal power unit supported by the vehicle structure, a power storage unit supported by the vehicle structure, a plurality of wheels rotatably coupled to the vehicle, an AC electric motor coupled to at least one wheel, a drive controller coupled to the AC electric motor, a vehicle controller coupled to the drive controller and a data bus network, and an AC bus assembly coupled to the principal power unit, the power storage unit, and the AC electric motor through the drive controller; and using the data.

[0011] There is also provided a method including providing internet access to data representative of a vehicle of the type including an AC bus assembly for interconnecting removable modules of an electric vehicle, the modules including a principal power unit that is not a battery, a power storage unit, an AC electric motor coupled to at least one wheel of the vehicle, a drive controller coupled to the electric motor, an energy dissipation unit, and a vehicle controller having a user interface, the AC bus assembly comprising: a first conductor having a first end and a second end; and a second conductor having a first end and a second end, wherein the first end of each conductor is coupled to the principle power unit and the second end of each conductor is connected to one of the modules; and using the data.

[0012] There is additionally provided a method including communicating over a network data representative of a vehicle of the type including: a vehicle support structure, a plurality of wheels rotatably supported by the vehicle structure, wherein at least two of the wheels are steerable, a principal power unit supported by the structure, wherein the principal power unit is not a battery, at least one AC electric motor coupled to at least one of the wheels, an electric AC power bus including at least two phase conductors, wherein the phase conductors are coupled to the principal power unit, a power storage unit coupled to at least one of the wheels, a vehicle controller coupled to the AC power bus, a data bus coupled to the vehicle controller, and a motor drive controller unit coupled to the electric motor and to the data bus to communicate signals to the vehicle controller such that one of the speed and torque of the motor are controlled base upon the signals; and using the data.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Figure 1 is a schematic diagram of an exemplary embodiment of an electronic traction vehicle providing an exemplary embodiment of an A/C bus assembly coupled to various modules on the vehicle.

[0014] Figure 2 is a top plan view illustration of an exemplary embodiment of a differential assembly coupled to an electric motor for driving at least two wheels and supported by a suspension assembly.

[0015] Figure 3 is an end view partial sectional view of an exemplary embodiment of an electronic traction vehicle support structure coupled to a suspension assembly which suspends at least one wheel relative to the vehicle support structure.

[0016] Figure 4 is a schematic block diagram illustrating the various entities connected to the Internet for the transmission of data indicative of an electronic traction vehicle.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0017] An electronic traction vehicle 10 as illustrated in Figure 1, comprises a vehicle platform or vehicle support structure 12 upon which various modules 84 are removably mounted. Such modules 84 include a principal power unit 16, a power storage unit 22, an electric motor 28 coupled to at least one wheel 14 of the vehicle 10, a drive controller 30 coupled to the electric motor 28, an energy dissipation unit 32 and a vehicle controller 34 having a user interface 36. Additional modules generally referred to as auxiliary modules 86, can be added to the vehicle 10 as circumstances and the situation warrants.

[0018] Interconnecting the modules 84 on the electronic traction vehicle 10 is an A/C Power Bus Assembly 42 and a data bus network 76 through which the vehicle and its various functions are controlled and operated. Specific descriptions of the various modules 84 and their functions will be described hereinafter.

[0019] One embodiment of electronic traction vehicle 10 comprises the work platform 12 with a principal power unit 16 mounted on the vehicle platform 12. A power storage unit is mounted on the vehicle platform with a plurality of wheels, rotatably mounted on the vehicle platform with an electric motor 28 coupled to at least one wheel. A drive controller 30 is coupled to the electric motor. A vehicle controller 34 having an input terminal 38 and an output 40 terminal is coupled to the drive controller 30 and a data bus network 76. The vehicle controller 34 receives data input

from monitors and sensors, as well as from the operator input terminal 38, concerning the speed and power required for vehicle 10 operations. The torque output of each motor 28 is adjusted to meet the requirements established in the vehicle controller 34 from such data input. Coupling the principal power unit 16, the power storage unit 22, and the electric motor 28 through the drive controller 30 is an A/C bus assembly 42. In some instances, the vehicle controller 34 is coupled to one of the principal power units 16 and the power storage unit 22 as determined by an operator of the electronic traction vehicle 10. A continuous track, supported by the wheels 14 can, also be provided.

[0020] The electronic traction vehicle 10 can be configured with one or more modules 84 consisting of modular independent coil spring suspensions for steerable and non-steerable wheel assemblies and driver and non-driver axles. Details of such modular independent coil spring suspensions can be found in U.S. Patent Nos. 5,538,274, 5,820,150 and 6,105,984 incorporated herein by this reference, which are assigned to the assignee of the present invention.

[0021] The principal power unit 16 includes a prime mover or engine 18 coupled to a generator or alternator 20. The prime mover 18 can be a fuel cell, a gas turbine, an internal combustion engine or a nuclear power device with the preferred embodiment being a diesel engine. The generator/alternator 20 is coupled to the prime mover and preferably is a synchronous generator producing 460 to 480 volts, three phase, A/C 60 hz power for the electronic traction vehicle 10. However, it is contemplated that different sized generators or alternators can be coupled to the prime mover for purposes of generating either higher or lower electrical power. For instance, a single phase system can be utilized or a system that generates 720 volt power system can be used or a system that operates at a frequency other than 60 hz, such as 50 hz which is typical in European countries. It is also contemplated that the power generated by the principal power unit 16 can be modified by appropriate auxiliary modules 86 such as a step-down transformer to provide power to operate

ancillary equipment on or associated with the electronic traction vehicle 10 such as pumps, instruments, tools, lights and other equipment.

[0022] Various embodiments of an electronic traction vehicle 10 are based on the number of wheels 14 that are driven on the vehicle 10. For instance, one embodiment includes an electric motor 28 and drive controller 30 coupled to another wheel 14 and coupled to the data bus network 76 and the A/C bus assembly 42. The vehicle 10 can also include four electric motors 28 and four drive controllers 30 which are coupled to four wheels 14 and coupled to the data bus network 76 and the A/C bus assembly 42. As shown in Figure 1, at least 8 electric motors 28 and electric drive controllers 30 can be coupled to 8 separate wheels 14 and coupled to the data bus network 76 and the A/C bus assembly 42. In all variance of the electronic traction vehicle 10, at least two of the wheels are steerable.

[0023] The A/C bus assembly 42 includes a plurality of phase conductors 44. A first conductor 46 having a first end 48 and second end 50 together with a second conductor 52 having a first end 54 and a second end 56 can be configured together with a neutral 64 to provide single phase power in one embodiment of the vehicle 10. A third conductor 58 having a first end 60 and a second end 62 can be used in conjunction with the first conductor 46 and the second conductor 52 to provide three phase power as shown in Figure 1. The conductors 44 can be stranded metal wire such as copper or aluminum sized and clad to transmit the power generation contemplated in the vehicle 10 design. The conductors 44 can also be solid metal bars, generally referred to as bus bars, composed of appropriate clad metals, such as copper or aluminum, as will be appreciated by one ordinarily skilled in the art.

[0024] The electric motor 28 can be an appropriate sized traction motor. An exemplary embodiment of an electronic traction vehicle 10 will provide an A/C, three phase induction electric motor. The motor would have a simple cast rotor, machine mount stator and sealed ball bearings. There would be no brushes, internal switches or sliding contact devices with the rotor as the only moving part of the

traction motor. Control of the electric motor is achieved through a drive controller 30 which is coupled to the motor. The torque output of the motor 28 is adjusted based on the rotational speed and power requirements established by the operator at the vehicle controller 34 and transmitted to the drive controller 30 over the data bus network 76. The drive control 30 is coupled by a data bus 72 into a data bus network 76 which is connected to the vehicle controller 34. Signals 74 generated by the vehicle controller 34, and the drive controller 30 and other modules including auxiliary modules 86 and sensors are processed by the vehicle controller 34 with appropriate input 38 and output provided by the user interface 36. It is also contemplated that wireless communication between the vehicle controller 34 and the various modules 84 can be achieved including communication of signals 74 via radio waves, microwaves, and fiber optical paths including relay via satellite to a central command center.

[0025] Figures 1 and 3 illustrate the wheels 14 being driven directly by an electric motor 28 through an appropriate wheel-end reduction assembly 82 if necessary. A wheel-end reduction assembly 82 can also couple the wheels 14 to a differential assembly 78 via drive shafts. A plurality of wheel-end reduction assemblies 82 can couple the wheels 14 to their respective electric motors 28. Another embodiment of the vehicle 10 includes a differential assembly 78 coupled to the electric motor 28 for driving at least two wheels 14 as shown in Figure 2. Additional differential assemblies 78, such as three assemblies 78, with each differential assembly coupled to an electric motor 28 for driving at least two wheels, can also be configured in the vehicle 10.

[0026] As mentioned above, the vehicle 10 can be provided with the principal power unit 16, the power storage unit 22, the electric motor 28, the drive controller 30, the vehicle controller 34, the suspension assembly 80 and other associated equipment as modules 84 that may be removably mounted on the vehicle platform. The modules 84 are also removably connected to the data bus network 76 and the A/C bus assembly 42. An auxiliary module 86 can be any type of equipment or tool required or associated with the function and operation of the vehicle 10. For

example, the auxiliary module can be a pump, a saw, a drill, a light, etc. The auxiliary module 86 is removably connected to the data bus network 76 and the A/C bus assembly 42. A junction 88 is used to facilitate the connection of the modules to the data bus network 76 and the A/C power bus assembly 42 and are located at convenient locations throughout the vehicle 10. The junctions 88 can accommodate various types of connections such as quick connectors, nuts and bolts, solder terminals, or clip terminals or the like. The junction 88 can accommodate the data bus 72 or the phase conductor 44 or both.

[0027] Also connected to the A/C power bus assembly 42 is the power storage unit 22. The power storage unit 22 includes an electric power converter 24 and an energy storage device 26. The energy storage unit 22 can be configured to provide electric power above and beyond that required of the principal power unit 16. The energy storage device 26 can be electric capacitors, storage batteries, a flywheel, or hydraulic accumulators. The electric power converter 24 can be configured to convert the A/C power generated by the principal power unit 16 to D/C power and transfer such converted power to an appropriate storage device. The electrical power converter 24 can also convert the energy stored in the energy storage device 26 back to A/C power to augment and supplement the A/C power generated by the principal power unit 16 over the A/C power bus assembly 42. Applicants have determined that an additional 200-300 horse power of short-term power can be provided into the A/C power bus assembly 42 over the phase conductors 44 by discharge of an on-board battery pack (energy storage device 26) under control of the power storage unit 22. The power storage unit 22 may be coupled to the data bus network 76 and controlled by the vehicle controller 34. The combined electrical power from the principal power unit 16 and the power storage unit 22 will all be available on the A/C power bus assembly 42 for use by the electric motors 28 or by any other module 84 or auxiliary module 86 as determined by the operator at the user interface 36 of the vehicle controller 34.

[0028] In operation, the power storage unit 22 receives power from the principal power unit 16 over conductors 44 of the A/C power bus assembly 42. The power received is converted into the appropriate energy mode required by the energy storage device 26 and maintained in the energy storage device 26 until required during the operation of the vehicle 10. If the principal power unit 16 is not functioning for any reason, the energy in the power storage unit can be utilized to operate, for a given period of time, the vehicle 10 or any of the modules 84 or auxiliary modules 86 mounted on the vehicle 10.

[0029] Energy storage recharge of the power storage unit 22 by the principal power unit 16 will begin automatically and immediately after the vehicle 10 arrives at its destination and will continue during the vehicle's return run to its original location. The state of charge of the power storage unit 22 will be maintained between missions by a simple plug connection to a power receptacle in the vehicle's garage or storage location, which receptacle will automatically disconnect as the vehicle 10 leaves such site. The power storage unit 22 can also receive energy generated by the electric motors 28 when the motors are configured in a regeneration mode in which case they will function as a generator. Such functionality is utilized in a braking procedure for the vehicle is determined by the operator at the user interface 36 of the vehicle controller 34. The electric motor 28 and AC power bus assembly 42 can also be configured to regenerate power back to the principal power unit 16.

[0030] An additional module 84 that is provided in another embodiment of the vehicle 10 is an energy dissipation unit 32 coupled to the A/C bus assembly 42 and the data bus network 76. If it is determined that the principal power unit 16 or the electric motors 28 or any other auxiliary module 86 generating too much power or are not utilizing sufficient power, the excess power can be dissipated through the energy dissipation device 32. An example of an energy dissipation device 32 is a resistive coil that may be additionally cooled by fans or an appropriate fluid. Another example of an energy dissipation unit 32 is a steam generator which utilizes excess heat generated in the vehicle to heat water to produce steam.

[0031] Referring to FIGURE 4, a method of transferring data indicative of an electronic traction vehicle 10 to potential customers over the Internet 92 includes obtaining information on an electronic traction vehicle 10 including dates, prices, shipping times, shipping locations, general shipping data, module type, inventory, specification information, graphics, source data, trademarks, certification marks and combinations thereof. The method further includes entering the information on to a terminal 90 that is operationally connected to an Internet server. Terminal 90 may be a microprocessor, a computer, or other conventionally known device capable of operationally connecting to a conventionally known Internet server. The method further includes transmitting to the information from terminal 90 to the Internet server that is operationally connected to Internet 92. The method allows manufacturers 94, distributors 96, retailers 97 and customers 98, through the use of terminals 90, to transmit information, regarding the electronic traction vehicle 10 and the potential sale of the electronic traction vehicle 10 to customers, to one another individually, collectively or by any combination thereof.

[0032] Thus, there is provided an electronic traction vehicle of modular design with the modules interconnected by an A/C bus assembly and a data bus network. Although the invention has been described in conjunction with specific embodiments, thereof, it is evident that many alternatives, modifications and variations will be apparent to those ordinarily skilled in the art. For example, an electronic traction vehicle using a modular component design can be utilized as a fire truck for use at an airport or one that can negotiate severe off road terrain. The vehicle can also be used in a military configuration with the ability to negotiate extreme side slopes and negotiate extreme maneuvers at high speeds. The modular aspect of the vehicle architecture will allow for optimum placement of components to maximize performance with regard to center of gravity which will facilitate its operational capabilities. Accordingly, it is intended to embrace all such alternatives, modifications and variations that fall within the spirit and scope of the appended claims